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THE BEGINNINGS OF IRRIGATION IN THE UNITED STATES

I

The archaeology of Egypt and Assyria affords notable testimony of the initial activities of mankind in exacting a living from arid soils; but the mysterious lands of the East offer no greater lure to the student of early irrigation than do the broad plains and mountain-locked valleys of our own Southwest. Indeed, few prehistoric races have anywhere left plainer evidence of industrial conquest than have the ancient dwellers of the most forbidding desert lands of America. Modern industrial surgery is rapidly destroying visible proof of early irrigation; but there still remain some remnants of skilfully constructed irrigation works of no mean degree of magnitude, which in ages past made habitable the lands of the Gila, the Rio Grande, and the San Luis drainage areas in Arizona, New Mexico, and Colorado. It is even possible that the engineering triumphs of recent years have little more than reclaimed the plains and mesas of some of these districts to their ancient state of cultivation.¹

Between the Salt and the Gila rivers lies a fertile plain thirty miles in length which bears unmistakable evidence of an elaborate irrigation system long used by the ancients. Near Phoenix a wonderful irrigation project seems successfully to have diverted water from the stream by a tunnel driven several hundred feet through hard volcanic rock leading to a canal over twenty miles in length traversing a country of unusual roughness. Significant of the time and labor required for such construction are the remains of innu-

¹ The *Annual Report* of the Smithsonian Institution for 1904 contains an interesting description of some of the evidences of irrigation works of prehistoric origin in the Southwest.

Mr. W. H. Cody, of the United States Bureau of Irrigation, characterizes some of the ancient canals of the Salt River Valley as being of "grade and construction in accord with present knowledge of hydraulics in the recognition of safe velocities and coefficients of friction" (*Bulletin No. 86*, p. 111, Office of Experiment Stations, U.S. Department of Agriculture).

merable broken and worn implements of stone scattered along the line of this canal. This mute witness of ancient achievement is said to have suggested the feasibility of an irrigation economy to the wandering Mormons, resulting in the planting of a colony and the successful pursuit of agriculture upon lands irrigated from Salt River by water withdrawn at the point of ancient diversion.¹

On Clear Creek below Camp Verde in Arizona remain traces of a complete system for the diversion of water from that stream and its distribution over an area of 1,200 acres. A few miles northwest of Phoenix, on the Hassayampa River, appears evidence of the great length of time during which cultivation by means of irrigation was practiced by the ancients in that region. Water diverted from the stream was carried through a canal of considerable size over a ledge of volcanic rock, thence falling about forty feet to the plain below. At the edge of the falls the action of the water has cut away the rock wall for a distance which only centuries of erosion could have accomplished. It is the opinion of ethnologists that the eighth and ninth centuries witnessed a highly developed agriculture and a dense population in the valley of the Salt River.² Not only does this section have historical interest as the probable birthplace of American irrigation, but at the present time it is the site of the most daring and extensive reclamation project ever undertaken.³

Sixty-five years before the "Mayflower" anchored off the coast of New England, Coronado, with a splendid army of three hundred Spanish horsemen and as many native footmen, crossed from New Spain into the arid lands of the Southwest. His object was the conquest of the "Seven Cities of Cibola," the streets of which were reputed by a wandering friar to be paved with silver and the better dwellings to be several stories high and ornate with gold and precious stones. The quested cities proved to be modest villages

¹ *Thirteenth Annual Report of the U.S. Geological Survey*, Pt. III, p. 136.

² Report of Frank Cushing, of the U.S. Bureau of Ethnology, in the *Thirteenth Annual Report of the U.S. Geological Survey*, pp. 133 f.

³ The Eagle Dam, now being constructed by the United States Reclamation Service about 100 miles north of El Paso on the Rio Grande, will be 205 feet high and 1,400 feet long, and will create the largest artificial lake in the world—a reservoir 40 miles long and 1 to 5 miles wide, containing 2,538,000 acre-feet of water.

of Pueblo Indians having no knowledge of gold or silver and possessing no other precious stones than a few turquoises. These villages, one of which is still occupied,¹ were located along the headwaters of the Little Colorado River in Arizona and New Mexico. Coronado's party continued northward probably as far as western Kansas, and returned after two years.

The writings of Coronado and some of his men afford the earliest documentary evidence of the practice of irrigation within the present confines of the United States. Certain tribes of Indians are described as living in villages built of brick and stone, cultivating fields in near-by valleys, and worshiping the water and the springs. Irrigation canals were observed, and abundant crops of maize, red beans, and squashes, and also some cotton, were mentioned.²

¹ The Pueblo of Acoma in New Mexico, about 50 miles east of Zúñi, having a population of 650. This is the oldest continuous settlement in the United States (*Spanish Explorations in the Southwestern United States*, p. 311, note 2; edited by F. W. Hodge).

² Specific mention of irrigation does not appear in the personal letters of Coronado or in the narrative of Castaneda, his companion and historian; however, frequent reference is made to the abundant harvests of the natives where irrigation was doubtless necessary to the growing of crops (letter of Coronado to Mendoza, Translation by Winship, *Fourteenth Annual Report U.S. Bureau of Ethnology*, pp. 561 and 569. Letter of Mendoza to the King of Spain, *ibid.* pp. 549-50. Narrative of Castaneda, *ibid.*, pp. 518 f.).

The narrative of Juan Jaramillo, a captain under the command of Coronado, does make specific reference to the practice of irrigation by the Indians. Discussing the advance into the neighborhood of southern Arizona, he says: "From here the general ordered ten of us horsemen to make double marches, lightly equipped, until we reached the stream of the Cedars (arroyo de los Cedros), and from there we were to enter a break in the mountains on the right of the road and see what there was in and about this. . . . This was done, and all that we saw there was a few poor Indians in some settled valleys like farms or estates, with sterile soil. . . . From here we went to the river Yaquemi, which took about three days. We proceeded along a dry stream, and after three days more of marching, although the dry stream lasted only for a league, we reached another stream where there were some settled Indians who had straw huts and storehouses of corn and beans and melons (squashes). Leaving here, we went to the stream and village which is called Hearts. About two days were spent in this village of the Hearts. There is an irrigation stream and the country is warm. They have corn, and beans and melons for food, which I believe never fail them. . . . We went on from here, passing through a sort of gateway, to another valley near this stream, which opens off this same stream, which is called Senora. It is also irrigated and the Indians are like the others and have the same sort of settlements

Nearly four centuries have passed, and the lands explored by Coronado have been successively exploited by the cavalier and militant priest of Spain and appropriated by their ever-successful Teutonic rival. Nevertheless, the Pueblo Indian survives and persists in the ways of his fathers. On the scant fields surrounding the Pueblos of New Mexico and Arizona one may, today, observe irrigation and cultivation as in the days of the Spanish conquest. Conduits now in service retain the sediment of centuries in their banks and the custom of their use, which has there become the recognized law of water-right, is of unrecorded origin.

The Mission fathers of the Jesuit and Franciscan orders, having observed irrigation in Spain and Mexico, were first to utilize the streams of California for irrigation agriculture. Their first irrigation ditch appears to have been constructed near San Diego Mission about 1770. There soon followed other small irrigation works at the Mission of San Juan Capistrano in 1776, and at San Fernando two years later. Water was diverted from the San Gabriel River by the mission of that name in 1821, and during the same year a project of considerable magnitude was undertaken by the Padres on Mill Creek in the San Bernardino Valley.¹

As with all things Spanish in the New World, the irrigation work of the Padres was not carried beyond the most elementary accomplishments; and the opportunity for the building of an empire on the Pacific which remained in their grasp for a century was released to the industrial conquest of the Anglo-Saxon. Such attempts at irrigation as were made by the California missions in the eighteenth and early part of the nineteenth centuries may scarcely be said to represent a beginning of the irrigation economy of the West. Surrounded as these hooded adventurers were by a wealth of natural resources potentially overshadowing the

and food." *Ibid.*, pp. 584 f. These settlements were probably a little way south of the Arizona boundary; however, the same methods of cultivation seem to have obtained farther north. Writing of the Indians of New Mexico, Coronado says: "They cultivate the ground in the same ways as in New Spain."—*Ibid.*, p. 549.

¹ Interesting descriptions of the agricultural enterprise of the Catholic missions in California are contained in *California and Its Missions*, by J. B. Clinch; *In the Footprints of the Padres*, by S. F. Stoddard; and *In and Out of the Old Missions*, by G. W. James.

storied treasures of the Incas, their institutions on the Pacific slumbered on in a way quite characteristic of the industrial inertia of the Spanish people. Thus, it remained for the gold-hunters of 1849 and 1850 to open the treasure vaults of the Sierras, and, subsequently, to quicken the parched soils of the western slope into agricultural productivity.

II

No one of the western states can trace its social and industrial institutions to more subtle and persistent creative forces than does the commonwealth of Utah. Nor may the pioneers of any community recite more harrowing experiences or enumerate greater economic obstacles than were survived by the exile followers of Brigham Young in establishing the Mormon colonies upon the frontier.¹

So far as we have knowledge, the Utah settlers never witnessed the practices of irrigation before themselves applying them. Under the stress of immediate necessity, and with determination and discipline bred of a thoroughly tested religious zeal, they set themselves to the task of discovering and applying an economic and equitable theory to this new sphere of agriculture. The Mormons were well fitted for the struggle with an obstinate environment. Out of the years of social ostracism and the physical hardships of a notoriously daring migration into an unknown wilderness, they brought to Utah a thoroughly disciplined hierarchy which recognized harmony and co-operation to be the cardinal principles of economic efficiency. Mormon institutions were thus developed in an atmosphere pervaded by religious devotion to patriarchal authority. They strove to realize co-operative production and

¹ In an address before the Irrigation Congress in Salt Lake City, President Wilford Woodruff stated that immediately upon their settlement in Utah, in 1847, the Mormons discovered that it would be impossible to raise crops with the small rainfall occurring in that region. They hit upon the idea of utilizing the waters of City Creek and other streams to aid in maturing their crops, and they soon learned to do this most conveniently by diverting water from the higher points of the streams and carrying it from the main canal into the fields by means of lateral ditches.

In 1849, two years after first breaking sod and diverting water for irrigation, the Mormon colonists harvested 130,000 bushels of wheat, in addition to other grains and extensive root crops, from an area of 17,000 acres of land, most of which was under irrigation (H. H. Bancroft, *History of Utah*, chap. 27).

communistic distribution. Herein lies the magic of the rapid and systematic growth of the irrigation system near the Great Salt Lake, and the consequent prosperity of the settlements in Utah.

In contrast with the substantial and orderly developing of the Utah colonies, we observe California, Colorado, and other arid states settled and exploited by adventurous fortune-seekers who were precipitated upon the country in little more than a day by reported mineral discoveries within its boundaries. All comers were competitors in robbing the land of such virgin wealth as was readily at hand. Settlers were characteristically individualistic in thought and action. None gave consideration to a possible permanent social organization, and few, in fact, to contemporary or coexisting interests of others. In these states irrigation agriculture was, at first, merely incidental to the transient interests of the early mining settlements and was consequently impeded by the spirit of personal and sectional independence and rivalry which dominated the environment of its birth.

Co-operation in ditch-building and water-distribution was, for years, unknown in Colorado after irrigation had been demonstrated to be feasible and profitable. Because of the independent and non-conciliatory character of the settlers, the first attempts at co-operative ditch-building in Colorado were sad failures.¹ In California, a degree of co-operation was forced upon the placer miners in the beginning, because of the extent of the placer fields and the relative scarcity of water available for mining purposes. Customs controlling the distribution and use of water in the mining camps were later applied with slight modification to the use of water for irrigation. Although personal co-operation was thus early introduced in the diversion and distribution of industrial waters in California, the application of the *rule of the mine* to the agricultural use resulted in a bitter conflict of sectional interests involving the two industries.

¹ A co-operative undertaking near Denver failed in 1860 after \$10,000 had been expended. This was the first project of importance undertaken in the state. Shortly afterward, a German colony at West Mountain Valley disbanded for lack of harmony in working out an irrigation system. Ten years later, Union Colony at Greeley almost came to grief on the rock of co-operative ditch-building.

Irrigation, by its nature, is pregnant with problems soluble only by co-operative and harmonious action, or by the exercise of administrative authority to a degree inconsistent with the frontier conception of democracy. The influence of extreme individualism in matters of proprietorship and industrial activity has continually obstructed the development of irrigation institutions. Today the courts of some western states are choked with litigation in irrigation matters which a comprehensive body of laws or customs, designed to contribute to the industrial efficiency of natural resources and to the general welfare of irrigation communities, would have prevented.

The early development of Utah's industries was significantly free from the competitive friction of individualism. Co-operation was a leading principle of Mormon activity, and unity of action marked every early undertaking in the desert colonies beyond the Rockies. They sought from the first to establish permanent institutions, and they proposed to build them upon an agricultural economy and to build for the common benefit. When they found successful agriculture to be impossible without the artificial watering of crops, they set out to develop an efficient system in an economical way. The *esprit de corps* of their organization assured success in canal-building, and their equitable policy of proprietorship and central administration so expedited the management of irrigation waters as to promote the highest interests of the community—interests conceived of as incorporating the welfare of coming generations.

The writer has elsewhere treated the *possession-proves-ownership* policy of frontier water-rights in other states and the manner of its surrender to the doctrine of priority of appropriation—both of which are exemplifications of *laissez-faire* theory.¹ It is there observed that existing irrigation institutions in America are not far enough removed in time from the environment of a primitive democracy, which gave them birth, to make possible the elimination of certain elemental defects which tend to inefficiency and inequity in their operation. The early practices of the Utah

¹ "Abrogation of the Common Law Doctrine of Riparian Rights," *American Political Science Review*, November, 1907.

irrigators gave no hint of the recognition of this doctrine. Neither do we find in them a recognition of the miners' code of water-distribution, nor evidence of a following after European methods of administration. They were sensible only of their economic needs and the ideals of unity and perpetuation resulting from a faith and experience which had made of them, in a sense, the most fearless and determined of American pioneers. No adverse interests existed within the sphere of their early activities to interfere with, or contradict any course of industrial development they might choose to follow. No natural differentiation of environment lent itself to dissenting opinion or practice in the appropriation or utilization of nature's productive powers. Under these social and economic conditions was formulated the "Old Utah Code" which defined the rights and obligations of the Mormon colonists in the use of flowing waters for irrigation.

The Utah Code, which, with provisions for its administration, became a law at the initial session of the territorial legislature in 1852, is characterized by Elwood Mead, former chief of the United States Bureau of Irrigation, as containing "some of the best features of the highest development of irrigation law as it is now understood."¹ This legislation, with elaborations of only slight theoretical significance, was sufficient to direct the remarkable growth of irrigation agriculture in Utah for forty-five years. The life of the Utah Code culminated in 1897, when the Mormon spirit of 1847 ceased to dominate the industrial development of the state.²

Until recently, the generally prevailing industrial motive of the West has been fortune-getting, at the risk of a temporary and uncertain economic and civic structure. This *general motive* did not prevail among the Mormons. From the beginning the primary objective of the Utah pioneer was social security and civic well-being in the highest light of his creed. Therein was the mainspring

¹ *Irrigation Institutions*, p. 211.

² Co-operative practices, in canal-building and the remarkable efficiency of communal utilization of irrigation waters, have not made the adjudication of titles to water-rights under the new law and in accordance with the prevailing doctrine of priorities an easy matter. Early indifference to the significance of priority of appropriation, in the determination of proprietorship interests, makes the application of prevailing principles of water-rights in Utah most difficult.

of Mormon progress and of the phenomenal growth of Mormon institutions while they remained free from influences beyond the control of the Elders. A willingness to lend thought and effort, at the sacrifice of immediate gain, to the security of the future raised the Utah settlers, in less than half a century, from abject poverty into comparative wealth and a condition of superior productivity. In this success we recognize the result of a wholesome co-ordination of individual effort to a common purpose in the practice of irrigation agriculture.

III

The middle of the nineteenth century marked the substantial beginning of the modern irrigation system of the western hemisphere. A few Mexicans and Pueblo Indians had practiced arid agriculture since prehistoric times; the missions near the Pacific had partially maintained themselves by irrigated crops for nearly a hundred years, and the Mormon colonists were rapidly reclaiming the fertile valleys leading westward from the Rocky Mountains. During this preliminary experience irrigation had not assumed institutional characteristics. Local customs were established, but they were lacking in uniformity and had not been accorded legal recognition; indeed, they existed without the pale of the law, and, if not illegal, they were at least clearly extra-legal.

With the middle of the century came the rush of the gold-seekers to the Pacific slope and the supplanting of Spanish dominion in California by a cosmopolitan society. Heterogeneous as was the mass of California settlers, the Anglo-Saxon character dominated, and, consequently, the spontaneous social organization tended to develop in directions more or less consistent with custom and law prevalent in England and the eastern states.

The usual method of mining in the old days was by crude placer processes which required diversion of water from the mountain streams through ditches and flumes to the placer fields. Miners, in thus conducting water from the lower streams of the Sierra Nevada Mountains, discovered that the leakage and overflow from their rude sluices and the run-off from their workings stimulated a rapid vegetation on the gentle slopes and in the valleys below.

Little imitative ingenuity was required to accomplish the artificial watering of grass and vegetables in a successful attempt to supplement the meager and uncertain forage and food supply, and in a short time the wonderful fruits of the semi-tropics were being grown in the same manner. Thus was realized the essential beginning of California's irrigation economy as an incidental result of primitive mining methods. As the early placers became exhausted, and later when many placer fields were abandoned under the operation of the *anti-débris law* of 1893, numerous streams were permanently turned from the sluices and pipes of the gold-miner and utilized to win the extraordinary products of a highly specialized agriculture from the soil. Even the original miners' canals were in many cases converted to irrigation, and a few such survive in this use to the present day.

California embodied an unusual variety of topographic and climatic conditions which gave rise to a rapid diversification of economic interests as settlement progressed. Natural humidity, which makes irrigation unnecessary or of slight importance in the northern reaches of the state, gradually decreases toward the sun-scorched but fertile valleys of the southern portions. The great central plain of the state, cradled between the lofty ranges of the Sierra Nevada Mountains on the east and the broken ridges of the Coast Range on the west, articulates the northern and southern areas of contrasted climatic characteristics. A multitude of small streams from the snowy slopes of the inland range form the Sacramento River in the north and the San Joaquin River in the south. These streams enter the valley from opposite directions, traverse the greater length of the state, and finally converge to mingle their waters with the Pacific at the Golden Gate. Thus we find in California a variety of physical conditions which roughly divide the state into three topographical districts, each with economic interests widely different from the others. In the north lies a region sufficiently watered by rainfall for the practice of humid agriculture. Farther south, to the neighborhood of Bakersfield and Tehachapi, a dry climate prevails with an abundant flow of water in the rivers leading from the mountains. In this middle area, irrigation is necessary for the maturing of crops and may be accomplished with

comparative ease by a systematic diversion and distribution of water from the streams. As one journeys farther southward, the soil and atmosphere become increasingly dry, and streams and springs rapidly decrease in size and number so that irrigation of only a small proportion of the land is possible and a most careful economy of water is necessary. Here, also, lie the remarkable fruit lands so susceptible to intensive culture, and consequently rendering fabulous values to the irrigation usufruct.

In the single state of California, one observes a combination of physical differences and economic conflicts arising therefrom which fairly represent the fundamental bases of controversy on questions of irrigation policy. Physical conditions result in community interests so radically different that concerted action in the development of a comprehensive system over so large an area is not to be expected under a régime of frontier democracy. The conflict of interests has at times appeared throughout the entire irrigation country, and is now especially keen in the zone intervening between aridity and humidity. Where state and national lines impinge upon this controversial zone and questions of sovereignty are involved, matters of irrigation policy are particularly vexatious and uncertain. Had California's settlement been less sporadic and the industrial development of the state more evolutionary, more amicable relations would doubtless have been established among sections having widely diversified physical characteristics, and consequently having different industrial motives. So keen has been the contrast of community interests that many people of southern California entertain the opinion that their economic conditions and political needs differ from those of the northern half of the state to such a degree as to justify for them a separate government.

California was populated by many thousands in a single season. Mineral discoveries have often created frenzied crusades into the wilderness areas of America. Without waiting for the rumor of "gold at Sutter's mill" to be confirmed, hastily formed caravans of adventurers struck the narrow trails leading westward to California. Saddle paths, first marked by Pike, Long, and Fremont, and thereafter frequented by trappers and fur-traders, became

beaten highways wide enough for the passage of an army. The first stampede of the gold-hunters was to the placer districts near the Pacific coast. Thence, many returned in disappointment to their homes or retraced their steps to Colorado or Utah. Others, defeated in their search for the yellow metal, determined at any hazard to get a living off the country, and quickly developed the more substantial agricultural industries throughout the district.

California's early population is said to have claimed the blood of all nations and the law of none. In the beginning, there were no recognized agents of public authority and each settler became law unto himself. In the absence of the protection of law, individuals were soon forced to unite with their neighbors in defining and safeguarding their proprietorship claims. Each settlement acted independently in this matter and, consequently, there were established discordant customs which have not yet been entirely harmonized by the legislature and the courts, and are today apparent in irrigation practice.

It has been asserted that the communal customs of the mission settlements were consciously perpetuated by the original irrigation district law of California. It is also stated that the California system was transplanted from southern Europe, and for this reason is essentially different from the systems of other states which, like Topsy, sprung from natural environment.¹ On the contrary, the only expedient methods of irrigation applicable to economic and social conditions in California were by force of circumstances adopted. Their similarity to European systems, if not fancied, is quite accidental. Any relationship between existing irrigation institutions in California and the primitive establishments of the Catholic missions is equally improbable.

IV

Progressive irrigation on the Pacific slope antedated by only a decade the third germinal point of the industry in Colorado. The Platte Canyon and Pike's Peak booms which drew thousands of people to Colorado within three years following the reported gold

¹ *Thirteenth Annual Report of the U.S. Geological Survey*, Pt. III, p. 143 (J. W. Powell, Director).

discoveries of 1857, created an intense demand for agricultural products. In the beginning, supplies were transported hundreds of miles from the middle western states by wagon-freight at rates which at times reached as much as 40 cents a pound on staple commodities.

In the spring of 1858, David K. Wall drew a tiny ditch from Clear Creek near the gold diggings then in progress among the foothills immediately west of the present site of Denver. With the aid of this water he developed a two-acre garden patch and peddled his produce to the camps. The miners, for months without other food supplies than flour, salt pork, and such game as the country afforded, took his simple vegetables at fabulous prices; and when he "weighed up his dust" at the close of the season he accounted a clear profit of two thousand dollars. The following year he doubled the extent of his agricultural operations and likewise the amount of the proceeds.

Pioneers, who had left farms in the east for the uncertain fortunes of a "prospector," deserted the gold camps and emulated the example and success of the first known irrigator of the Platte River country. Settlements appeared along the Platte and its tributaries with the suddenness of mushroom growth. Through the agency of rude irrigation ditches, luxuriant crops of "native hay" and the staple grains and vegetables were soon available for the needy camps in the mining districts. The ranks of the farmers were rapidly recruited from discouraged gold-seekers content to turn from fruitless ventures in the mountains to their former vocation of the soil. Many straggling California boomers, disappointed and returning to the "States," took advantage of the opportunities offered by the fortuitous combination of fertile soils and easily diverted waters in the valley of the South Platte and the keen markets of the near-by mining camps. In 1865, land was being irrigated and profitably cultivated at numerous points along the Platte and its confluents, including the Cache la Poudre and the Big Thompson rivers, and the St. Vrain, Boulder, Bear, and Clear creeks. The majority of these ventures were incidental to the mining operations within marketing distance of the lands cultivated, and the farmers were for a considerable time entirely

dependent upon the markets of the mining settlements for the sale of their products.¹

In 1870 appeared the pioneers of Union Colony—a project strongly supported by Horace Greeley and under the personal direction of N. C. Meeker, an associate of Greeley on the *New York Tribune*. The members of this company settled at the junction of the Platte and the Cache la Poudre rivers in northern Colorado, a day's journey from the foothills of the Continental Range. This was meant to be an agricultural settlement, and the Union Colonists looked to the achievement of permanent self-sustaining homes and the organization of a co-operative society which should be free from the usual concomitant of communism and from certain unsocial characteristics of individualism and competition as well. It is worthy of comment that the home of Union Colony (now the city of Greeley with a population of nearly 10,000) is on the western margin of the "Great Desert" which Major Long sketched on the map of the United States in 1820, and which, at the opening of the century, Lieutenant Zebulon M. Pike designated as incapable of cultivation and fit only for the habitation of the uncivilized aborigines of the country.²

¹ Wheat flour at \$1 a pound, \$30 a bushel for potatoes, and \$100 a ton for hay are examples of prices paid in the early days for Colorado produce.

The Colorado courts have decreed rights under the present law to water for irrigation in the Platte River valley, based upon alleged diversion and use during the first three years of this period of development, as follows: 1859, 128.43 cubic feet per second; 1860, 518.29 cubic feet; 1861, 1,052.14 cubic feet (U.S. Office of Experiment Station, *Bulletin No. 157*, pp. 27-38). One cubic foot of water per second should irrigate 50 to 80 acres of land. It is likely, however, that the decrees here cited are far in excess of water actually used. Decrees based upon priorities established as early as 1865 aggregate 4,601.61 cubic feet per second. This amount is equivalent to the maximum monthly flow of the South Platte, and all its tributaries. It probably represented an irrigated area of about 20,000 acres in 1865. Under existing conditions and methods, 70 acres is considered a minimum "duty" for one cubic foot of water.

² From Pike's first report, published by the United States government upon his return from the West, is quoted the following: "But from the innumerable prairies may arise one great advantage to the United States, i.e., the restriction of our population to some certain limits, and thereby a continuation of the Union; our citizens, being so prone to rambling and distributing themselves on the frontiers, will through necessity be constrained to limit their extent in the West to the borders of the Missouri and the Mississippi, while they leave the prairies, incapable of cultivation, to the wandering and uncivilized aborigines of the country."—Elliott Coves, *Expeditions of Zebulon M. Pike*, Vol. II, p. 525.

The settlement of the Greeley district was a positive and determined attempt to institute permanent agricultural pursuits dependent upon irrigation—the first of magnitude east of the Rocky Mountains. True, for ten years irrigated agriculture had been practiced along several streams flowing eastward from the mountains toward the distant Missouri; but such operations were avowedly incidental to mining operations farther back in the hills. Early miners and farmers were alike admittedly transients; each expected to abandon his labors and return to the East as soon as his “pile” was made or the gold “fagged out.” In the diversion and application of irrigation waters, these early cultivators consulted only their immediate individual interests. Their conduits were little more than simple furrows leading the water from the natural streams to private plots of ground and in no sense was there the semblance of an irrigation system serving a community interest.¹

The planting of Union Colony, with its respect for law and order, its co-operative ideals, its expectation of permanence, and its extraordinary administrative talent, marked the rise of promise above the plains of the Great Desert. There, was born the system of irrigation economy which persists in Colorado and has become the basis of effective arid-land agriculture in every western state.²

In Colorado the effective economic considerations and the order of development of irrigation institutions were materially different from those observed in the experience of California and Utah. Initial conditions among the miners of California and among the Mormon colonists of Utah were unique in their respec-

¹ Among the features of irrigation development in Colorado and neighboring states, mention should be made of occasional diversions of water dating back to the inception of the old trails and the trading-posts and way-stations along their routes. Such settlements along the Arkansas and Platte rivers at points on the Overland, Santa Fé, and Smokyhill trails carried water in ditches for domestic purposes and, possibly, for a few garden plots. Such irrigation, if indeed it may be properly called irrigation, constitutes no part of the development of existing institutions.

² Members of the original settlement at Greeley were, without exception, persons of education and of experience in business and agriculture. They were gathered from several states as the result of editorial communications in the *New York Tribune*. It was a colony of families who understood in advance the conditions and problems they were to face. Some were wealthy to a degree, and the undertaking was adequately financed from the beginning.

tive relations to the processes of industrial development. Colorado, on the contrary, has experienced conditions of settlement and development typical of the major portion of the arid West, and its history well portrays the normal operation of characteristic economic, social, and political forces generally potent in the substantial growth of irrigation practice and law. In California, an inevitable conflict of interests accounts for a compromise system of administration and proprietorship in the use of flowing waters. In Utah, extraordinary social arrangements gave rise to the phenomenal growth of a miniature system exceptionally efficient for a time, but destined to abandonment with the dissolution of the social forces by which it was created and circumscribed.

Colorado was first settled as a mining state, and agriculture and stock-raising were developed as auxiliaries to the initial industry. From the day of substantial beginnings, the mining districts have depended upon outlying farms and ranches for their food supply, and increasing numbers of farmers and graziers have found a convenient and profitable market in the metalliferous districts of the state. Furthermore, placer mining was never so extensive in Colorado as to contend with agriculture for the use of flowing waters, and in recent years mining other than lode-mining has become practically nil. For these reasons, the two leading industries of the state have been essentially non-competitive; and, indeed, a degree of mutual dependence has tended to create a spirit of co-operation between the mining and agricultural interests.

Physical conditions in Colorado are sufficiently uniform to dictate harmonious interests among practically all agricultural sections of the state, thus making general the larger economic and legal problems of irrigation. Occasional friction between individuals and among the smaller communities was, of course, inevitable during the earlier years of occupation and settlement; but serious conflicts have been avoided or amicably adjusted. In almost every instance, parties to contentions over the fundamental irrigation problems, such as doctrines of proprietorship and administration, have foresworn local interests and sought a solution in accordance with the general good. In these early controversies and in the means of their settlement, are revealed the prime desiderata which have given form to the present irrigation system of Colorado.

V

Within the present boundaries of Colorado, the pioneers of industry found about 40,000,000 acres of land fit for farms and pasturage, and 25,000,000 acres of metalliferous and timber lands. Most of the latter areas are located amid the heights of perpetual coolness where the natural precipitation of three seasons may be conserved and finally released in summer to the arid plains below. Thus we observe two classes of lands representing entirely different potentialities, namely, mineral and timber areas in the mountains and arable and grazing lands in the valleys and on the plains. As between these areas there lies no cause for conflicting interests in the process of their settlement and development; and indeed, as between mining and lumbering interests in the highlands, no friction may arise. But the changing and overlapping boundaries of the ranges and the fields, and the alternative uses of land and water by the grazer and by the farmer, gave rise to conflicting interests which were such as to constitute cause for a short but keen industrial warfare during the formative period.

The many small streams having their sources far back among the mountains are of surprising aggregate volume when they emerge from their tortuous mountain channels and take parallel courses across the plains. Shallow valleys border these streams, and soon give way, laterally, to roughly terraced plateaus or "bench lands." A half-century ago the mountain parks, luxurious with tall-growing grasses, were feeding grounds for innumerable deer and elk. The river valleys below, seldom more than a mile or two in width, produced considerable quantities of "wild hay" in the spring months from an alluvial soil overlying a gravel subsoil. The undulating bench-lands, reaching from valley to valley, produced a short growth of "buffalo grass" which cured to a light brown in summer and formerly constituted the sole food of the plains-herds of bison and antelope. During the period of occupation, the initial industries found congenial location without interference. The miner sought the placer sands and quartz veins of the mountain canyons and cliffs, the farmer chose to divert the streams in the valleys near the foothills to the lowest and most accessible lands, and the cattleman herded his stock to the prairie bunch-grass in summer and to the mountain parks

with their sun-cured forage and protective canyons in winter. For a time, harmony prevailed, save for an occasional controversy between a farmer who proposed to perfect his "claim" by fencing his lands, together with contingent streams and ponds, and some herdsman whose cattle habitually ranged upon adjacent prairies and drank from the aforesaid "water-holes."

With the passing of a few years, the desirable first-valley lands were all occupied. Thereafter, increasing settlement necessitated the construction of conduits of unusual length and capacity heading well up on the streams and delivering water far out upon the first and second bench-lands. These higher lands had previously been conceded to the stockmen, but when "brought under water" were generally found to be more productive than the valley lands first utilized by the farmers. Although areas so occupied were acquired for agricultural purposes in conformity with the public land laws, the intrusion of the homesteader upon the grass lands was resented by the stockmen and precipitated an era of "bad blood" in the arid country. Graziers saw their herds fenced farther and farther from convenient streams and water-holes and their prairie pastures gradually narrowing to the barren and non-irrigable bluffs which top the watersheds of parallel streams. Mountain pastures, formerly open to all rangers alike, were gradually acquired from the government, and from railway companies owning them by virtue of land subsidies, by the "little fellows" in the stock business. Fences were rapidly erected and the "public range" was gradually converted into private pastures and hay fields, and finally, where irrigation was possible, into farms having an exceptionally wide variation in production, much to the discomfort of the stockmen who, devoid of legal title in any lands, had presumed perpetual access to the natural pastures of the public domain.

Details of the short conflict between the irrigator and the ranchman are unnecessary. A period of lawlessness, such as fence-cutting, crop-destruction, ditch-breaking, and an occasional exchange of shots, accomplished the capitulation of the graziers. The Texas Trail, once the highway of great migrations of cattle from the southern to the northern pastures and to shipping points

on the early railroads, is now sealed by a thousand fences. The dry ranch with its uncounted herds of low-bred cattle and its halo of frontier romance is displaced by carefully tended fields devoted to special and general farming and to the rearing of high-grade livestock. This transition is about complete in Colorado, in California, and in considerable parts of other states, but it is still in evidence in some of the more recently settled sections of the West. During such transition times, the physical problems of the irrigator are augmented by social and political obstacles which tend to defer, and indeed to misdirect, the development of arid-land agriculture and auxiliary industries dependent thereon. The controversy between the drover and the tiller has but slight bearing upon the technical economic problems of irrigation; but the belligerent attitude of the stockmen, toward their successors in the occupation of the plains, has proved a menace to the enactment and administration of progressive water-laws. In the struggle for legal recognition of equitable and expedient doctrines and practices which have made possible a rational irrigation system, stockmen, such as were not themselves cultivators, generally associated themselves in opposition to any movement which promised economic opportunity or security of property rights to progressive agriculturists.¹

Subsequently to the preliminary skirmish with the range stockmen, the chief obstacle to the progress of the arid-land agriculturist proved to be dissension among the irrigators themselves. In Colorado, as in other western states, the annual precipitation

¹ In explanation of this situation, which is well understood in the irrigation country, the following is quoted from Boyd's *History of Greeley and the Union Colony of Colorado*: "The construction of this fence, undertaken as a peace offering to the stockmen, was not accepted in this spirit. In fact most of them did not want us here. They could easily see that the taking-up of their lands along the streams, and the fencing of them up, was going to be the death blow to the stock business in this region. They generally maintained the view that the country was good for nothing save for grazing, and that we were fools for undertaking to farm it. Hence our fence was ridiculed, and we were accused of being proud and wanting to keep ourselves to ourselves, as a peculiar and very holy people. We were Greeley 'Saints' who had fenced ourselves in from 'the heathen round about,' and the tone of some of Mr. Meeker's letters to the *New York Tribune* partially supported this view of the case. . . . The result of all this was a very hostile state of affairs between the people of Greeley and the stockmen, and some of them were of our own household" (p. 70).

is not adequate to supply moisture to all soil areas otherwise fit for cultivation, even under the operation of a highly developed system of irrigation.¹

For a few years unappropriated land and water were available, each in adequate amount to meet the needs of all comers. Each settler chose for himself, in actual or nominal compliance with the law, such lands as seemed best suited to his purposes and convenience. The available flowage of water in the streams not being commensurate with the area of arable soils, a time soon came when the earlier settlers and appropriators of water in the lower valleys found insufficient flowage to meet their needs reaching their headgates where, in former years, there had been a surplus. Later settlers had gone higher up on the same streams and there diverted water to be carried to new lands lying in the higher valleys and on the higher levels of the plains and mesas, thereby depriving the earlier settlers below. Sometime improved lands were consequently rendered valueless, and entire communities were threatened with depopulation because of the loss of irrigation waters in which they supposed they were secure.² In fact, "vested rights" were jeopardized and necessity arose for their statutory definition and security. Theretofore the doctrine of priority of appropriation, in its most primitive and general terms, had afforded the only control in the private use of public waters. In Colorado, this doctrine was nominally recognized from the

¹ In Colorado, probably 35,000,000 acres of land could be successfully farmed if the annual precipitation and "run-off" from the mountains were adequate. If the total rainfall could be conserved and scientifically utilized in irrigation, possibly 10,000,000 acres might be reclaimed. Practical limitations in the economy of water indicate a probable limit of 7,000,000 acres in all to be irrigated.

² Prior to 1866, no form of private water-right in streams flowing over public lands was recognized by the United States. Riparian rights, after the manner of the common law, were supposed to obtain upon private estates; but such rights were inconsistent with the irrigation use of water. Such statutes and judicial decisions, as recognized irrigation and mining rights in streams upon the public domain and in conflict with the doctrine of the common law, were born of the necessities of life in the western country and were effective only with the acquiescence of the United States government.

The federal law of 1866 attempted no positive definition of the irrigation water-right, but was confined to the ratification of "the local customs, laws and the decisions of the courts" pertaining to the diversion and use of water.

beginning; but for many years the courts repeatedly attempted its application with little avail.

When an irrigator was deprived of his customary supply of water by subsequent and adverse diversion, his only recourse was appeal to the courts in civil action against each and every offender, and the number and identity of offenders was usually a question of considerable uncertainty. Rights to the use of water were established upon such uncertain and conflicting evidence as prevailing frontier ethics in matters pertaining to the appropriation of natural resources led the parties to the action to present, by judges whose general knowledge of irrigation affairs was slight and whose legal training inclined their decisions toward the precedents of the common law. It is notorious that in the majority of the early cases evidence was openly made to order. However, in view of the manner of appropriating water for irrigation in those days, without official record of time or amount, in fact, without practical means of accurately measuring the amount, it must be conceded that conclusive evidence was in most cases non-existent. Judicial processes were slow and expensive. While the courts dragged through the tedium of procedure, crops died of drought and litigants became bankrupt; and decrees, when rendered, were often ineffective in actually measuring appropriations and in closing the headgates of offending users.

VI

The conditions above described reached a climax in the Cache le Poudre Valley in the summer of 1874. The general recognition of the judicial principle of "first in time, first in right" in the use of water for irrigation had proved ineffectual in guaranteeing the right of use when most needed. The water in the Poudre River was low that summer and the Greeley colonists claimed its use on the grounds of priority of appropriation. The farmers of the newly established agricultural settlement at Fort Collins, on the river twenty-five miles above Greeley, calmly proceeded to apply the available water to the irrigation of their flourishing crops while the fields about Greeley languished for want of moisture. Farmers of the two districts became belligerent, co-operation and

arbitration were suggested by the Greeley people without result, and conflict at arms seemed imminent. Courts were admittedly helpless without precedent, prescribed law, expert knowledge, or even means of enforcing a finding.¹

The Fort Collins-Greeley controversy crystallized the demand for a comprehensive body of irrigation law in Colorado and an adequate system of administration. The project was of course inaugurated and advanced by the earlier appropriators who believed themselves deprived by newcomers of their rights in the use of the streams, and conventions were called for the purpose of discussing and formulating proposed legislation. In 1876, when Colorado became a state, the doctrine of priority of appropriation was written into its constitution; but, until 1878, determined opposition deprived all irrigation bills of a comprehensive nature, the dignity of a hearing on the floor of the state legislature. Later appropriators, fearing that legislation on the subject would deprive them of privileges then enjoyed, fought the proposed laws untiringly. But, as time went on, "over-appropriation" increased and new ditches were taken out at points successively approaching the headwaters of the streams. The first offenders thus found themselves in the same position as the offended and were then willing to co-operate with their old opponents in the use of irrigation waters and in working for rational laws.

During the last week in December, 1878, a general convention was called in Denver. The reports of that convention detail one of the stormiest sessions of the notoriously turbulent deliberative assemblies of the state of Colorado. Most members of the legal profession allied themselves with the opposition to any form of legislation on the subject. In fact, the opposition was directed by the lawyers; and the water-users, who were contending for legislation which would define and protect their rights as among themselves, considered themselves fortunate to secure the services of sufficient legal talent to transcribe their plans into formal lan-

¹ Details of the water-right controversy of 1874 between the districts of Fort Collins and Greeley may be found in the daily issues of the *Rocky Mountain News* and the weekly issues of the *Greeley Tribune* for July, August, and September of that year.

guage and to draw a bill. It was claimed that laws regulating irrigation and clearly defining water-rights were not needed, that the administrative machinery, would be too expensive, and that the courts could decide questions as they arose more cheaply and satisfactorily.¹

It was then openly asserted, and the charge has been reiterated in other states under similar circumstances, that members of the bar were loath to admit a comprehensive code and permanent administrative machinery such as would eliminate much expensive litigation and consequent profitable parasitic employment for the profession.

A bill was finally formulated and placed before the legislature. It was distinctly a farmers' bill, simple in its terms, and designed to apply "the rule of reason" previously advanced in the leading opinions of the courts of the West in the definition of water-rights and in the distribution of the water supply among irrigators. The plan which it incorporated, as first outlined by the farmers of Greeley and Fort Collins, included the main principles which today survive in statutes of recognized excellence operative in several states. It provided for the districting of the state in accordance with natural drainage areas, for a water commissioner in each district, and for a state engineer in authority over all districts and responsible in all matters pertaining to irrigation development and to the distribution and use of diverted waters. The bill further specified a method of officially recording the time and the amount of water claimed in each instance of appropriation, and a system of gauging the flow of streams and measuring irrigation uses. Finally, it provided for the simultaneous adjudication of all claims "under" each stream, and the positive vesting of such rights in the use of water as the court finds to be in accordance with the state constitution and the statutory law of water-

¹ See speech of Senator L. R. Rhodes, in convention, December 27, 1878; also other discussion reported in *Rocky Mountain News* of December 27, 28, and 29.

Similar arguments were advanced to obstruct irrigation legislation in California and were there more successful than in Colorado, having accomplished the dismissal of the state engineer in 1888, and, indeed, being mainly responsible for the present ineffective system of that state.

rights.¹ After stubborn opposition, the bill was favorably reported from committees of both House and Senate and passed.

Victory was not yet accomplished. On the first application for a decree under the new law, Judge Elliott, sitting in the district court at Fort Collins, dismissed the application on the grounds of constitutionality, declaring that the statute made possible the taking of property without due process of law.² A similar case was later carried to the supreme court of the state where the law was again fought by unfeared lawyers of the old ring of obstructionists.³ The court held the statute to be constitutional, and thus effective irrigation legislation guaranteeing security in the rational utilization of irrigation waters became a reality.

The law soon grew popular and the most vigorous opponents of its enactment have since proclaimed it the "cheapest and most effective mode of controlling the industry."⁴ The original statute has been supplemented and judicially developed until irrigation law now constitutes a considerable proportion of the organic structure of the state.

The earlier irrigation practices and water-rights established in Utah and California have been recast, in so far as recognized vested interests will permit, to conform with the outlines of the Colorado system. New states have gone to Colorado for their principles of irrigation law and practice; foreign countries have sent commissions to study irrigation in Colorado, and have modified their laws and methods as a result of their inquiry.

VII

A question naturally arises as to the possible influence on American practice of irrigation methods which have long been in use in

¹ The following provision of the Colorado constitution is the foundation of the irrigation water-right resulting from the abrogation of the common-law doctrine of riparian rights and the adoption of the alternative right of exclusive proprietorship conditioned upon priority of appropriation and beneficial use: "The water of every natural stream, not heretofore appropriated, within the state of Colorado, is hereby declared to be the property of the public, and the same is dedicated to the use of the people of the state, subject to appropriation as hereinafter provided."

² *Greeley Tribune*, April 21, 1880.

³ *Chrisman v. Heiderer*, 5 Colo. 38.

⁴ Letter of L. R. Rhodes to William Hamm Hall, state engineer of California (unpublished).

Spain, France, Italy, and parts of Africa, and which were well developed at the time of the settlement of the West. There is no reason to believe that such foreign examples had any part in directing the development of irrigation in this country when the industry was young. It is doubtful if a half-dozen early westerners ever saw or were in the least familiar with foreign methods of irrigation. Even had they possessed a knowledge of such practices, physical and social conditions in this country were such that principles and methods in vogue abroad were inapplicable. In recent years, careful studies of foreign systems have been made by recognized leaders in irrigation development; but, with the possible exception of the suggestion of the California district plan, they have contributed nothing of value to the solution of the irrigation problems of a new country under our social and political system.¹

Not only were foreign irrigators without conscious imitation in America; but the early agriculturists on the Pacific slope, in the basin of the Great Salt Lake, and in the valley of the Platte River, were separated from each other by hundreds of miles of almost impassible mountain and desert country. Thus, each group worked out its own problems independently of the experience of the others, and each was free to develop a system of practice and law which should afford an expedient solution of its own immediate problems.²

¹In 1873 J. Max Clark, a member of Union Colony, called the attention of a convention of irrigators (which may properly be called the *first* national irrigation congress) assembled at Denver from Utah, Wyoming, Colorado, Nebraska, Kansas, and New Mexico, to significant facts relating to canal capacity and the duty of water in northern Italy. At that time expansive opinions of the possibilities of the irrigable lands of the West were being circulated by such men as William N. Byers, pioneer editor of the *Rocky Mountain News*, and Fred M. Stanton, an English engineer. These persons had estimated the area susceptible to reclamation within the state of Colorado at ten to twenty-five million acres, and asserted that there was sufficient water in the streams of the state to accomplish it. Mr. Clark attempted to prove the fallacy of these estimates, and, basing his calculations upon experience in Italy, he alleged the truth to be about one million acres (Boyd, *op. cit.*, pp. 92-99).

²In the *Greeley Tribune* of September 17, 1873, is an article by J. Max Clark expressing the disappointment of the Colorado irrigators in their attempts to secure information of value from the experience of early irrigators on the other side of the mountains in Utah. The following is an extract: "It may be said that while the Mormons have practiced it a little longer than we have, they know very little more

In concluding this narrative of the beginnings of irrigation in America, it is possible to enumerate the main causes which have determined the trend of events in each of the three cradle-spots of arid agriculture. Granting a common necessity for the artificial application of water to growing crops, certain characteristic physical and socio-economic forces exercise directive power.

Diversity of physical conditions is doubtless chief among the factors of variation in irrigation practice. Such differences may exist; first, as to the initial relative importance of the respective resources available to the mining, agricultural, and grazing industries, and the possible alternative uses of land and water; second, as to the changing relation of industries and the uses of water contingent thereon with the progress of settlement and development; third, as to different degrees of aridity prevalent in districts to be irrigated.

Likewise, a variety of social conditions have obviously affected the trend of irrigation development. These may be described as follows: first, initially recognized theories of proprietorship and industrial opportunity; second, effective law and custom enforced by authority and public opinion; third, contemplated objects of industrial activity; fourth, the influence of parasitic interests seeking to share in the benefits of the industry.

Utah, California, and Colorado, subject to the operation of a variety of more or less conflicting forces, followed lines of development expediently consistent with their respective physical and social environments, and the irrigation laws and usages thus independently established may approach uniformity only as underlying physical and social differences are eliminated or compensated. Utah, in 1897, abandoned a system rendered untenable by changed social conditions and adopted the Colorado system. California persists in irrigation laws and methods in some respects deplorably

about it, and except perhaps in the city of Salt Lake, they resort to very little more system than we do. They have, so far as I have been able to learn, contributed nothing to the world's store of knowledge on the subject, have written no books, advanced no new theories, recorded no new facts, and when, some three years since, the Farmers' Club of this place corresponded with some of their principal men upon the subject, with a view to ascertaining facts of importance for our own application and use, they were able to afford us nothing of practical value."

cumbersome and inefficient, because of a stubborn diversity of interests due chiefly to physical conditions. Colorado, fortunate from the beginning in possessing a relatively normal and uniform arid environment, has proceeded along a more rational course of evolution. Newer irrigation states, with exceptions due mainly to a lesser degree of aridity, have followed the example of Colorado and tend to approach harmony in the theory and law of water-rights and in their practice of irrigation. It is patent, however, that irrigation in the United States is still young. Forces, strong in the period of reclamation and exploitation of the waste places, become obsolete in the later periods of arduous development and recognized policies of conservation; economic and legal considerations once vaguely potential have become actual and effective, and may subsequently yield to a recognition of new motives as industrial evolution molds the institutions of the frontier in co-ordination with the changing functions of social progress.¹

¹ In addition to authorities cited in the footnotes, use has been made of all available records of the early industrial development of California and Utah, including newspapers published prior to 1875. The writer has also drawn upon personal observation during a period of nineteen years' residence in the Platte River valley in Colorado and upon information acquired through intimate acquaintance with many early settlers in the arid country.

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